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NEW SPECIES OF OLIARUS STÅL FROM SOUTHWESTERN UNITED STATES AND MEXICO

(Homoptera: Cixiidae)

BY JOHN S. CALDWELL
Circleville, Ohio

The following is a report on two small collections of cixiids; one received from the California Academy of Sciences through the courtesy of Dr. Edward S. Ross, the other from the Ohio State University through the courtesy of Prof. Josef N. Knull. The letters CAS after type desigation signify that the types are deposited in the California Academy collection at San Francisco, California; OSU denotes that the types concerned are deposited in the Ohio State collection at Columbus, Ohio.

Oliarus eximus Caldwell, new species

Length, male 6 mm.; female 6.3 mm. Black with carinae faint orange in male, deep orange in female. Elytra and main veins white in male with the following markings black; all punctations, junction of cubital veins with commissural margin, all cross veins, stigma, radius and cross strut to media including furcation of media and termination of all veins. Elytra in female with dark markings of male broadened often forming irregular dashes apically.

Frons deeply inserted into clypeus. Vertex of broad type, broader in female than in male; lateral margins parallel in basal half, convergent apically. Intermediate carinae of pronotum not reaching posterior margin. Mesonotum with median tablet very broad; lateral carinae as well as intermediate carinae slightly curved.

Male pygofer with lateral margins produced extremely far caudad; medioventral process greatly enlarged, rounded in outline. Forceps very long, curved around medioventral process of pygofer; broadened apically with inner and outer angles equally produced in ventral aspect. Anal segment long, somewhat flattened apically.

Aedeagus of reduced type as found in the placitus group; periandrium with three long and one short basal process.

Male holotype from SANTA ROSA MTS., CALIFORNIA, June 15, 1946; female allotype same locality, May 27, 1946; paratypes May 27, 1946, June 15, 1946, June 25, 1946 (D. J. & J. N. Knull), OSU.

Resembling *placitus* Van D. but differing by the lack of bifurcate processes on the periandrium and other phallic characters as noted in the description.

Oliarus eximus teximus Caldwell, new subspecies

Length, male 5.3 mm.; female 7.3 mm. Dark brown with lighter carinae. Elytra milky with brown veins in male. Elytra in female with a tendency for fuscous color to spread over the entire surface.

Male pygofer not produced as far caudad as in typical form; medioventral process proportionately larger. Forceps with inner apical angles produced more than outer. Anal segment hood-like, not flattened apically. Periandrium wtih all basal processes about equal length or with medioventral process a little longer than others.

Male holotype from BASTROP N. P., TEXAS, May 1, 1941; female allotype and male paratype, Uvalde County, Texas, May 3, 1941; female paratypes, Uvalde County, May 11, 1946, and Brownsville, Texas, May 8, 1935 (D. J. & J. N. Knull), OSU.

Lighter colored than typical form with more markings on female; slightly different phallic characters in male as noted in the description.

Oliarus forcipatus Caldwell, new species

Length, male 5 mm.; female 5.5 mm. General color black with all carinae light brown to deep yellow. Mesonotum with area between lateral and intermediate carinae deep yellow; lateroposterior margins edged in yellow. Elytra whitish hyaline; veins light brown, darkening apically.

Vertex elongate; lateral margins greatly elevated; facets almost half as long as vertex. Intermediate carinae of pronotum reaching posterior margin. Intermediate carinae of mesonotum close to lateral carinae, especially basally.

Male pygofer with lateral margins greatly produced caudad, acute; medioventral process short, stout. Forceps long, broadened and recurved apically. Anal segment elongate, hood-like. Aedeagus with two apical processes, caliper-like. Periandrium with left ventral process very broad, trifid apically; right ventral process slender, straight; a slender, straight process present dorsally.

Male holotype and paratypes, July 23, 1946; female allotype and paratypes, June 2, 1937, from DAVIS MTS., TEXAS (D. J. & J. N. Knull), OSU.

Differing from other oliarids by the phallic characters as noted in the description.

Oliarus abacus Caldwell, new species

Length, male 7 mm.; female 7.6 mm. General color light fuscous with all carinae and median tablet of mesonotum light brown. Veins light brown with dark brown punctations. Female with most cross veins and furcation of main veins broadly blackened, giving a mottled appearance.

Vertex longer than broad, broadly trough-like; facets short, triangular. Intermediate carinae of pronotum far from posterior margin. Carinae of mesonotum prominent; intermediate carinae evenly arcuate, slightly nearer lateral carinae than median. Posttibiae each with one or two spurs well basad. Punctations on veins very small.

Male pygofer with lateral margins produced well caudad on either side; medioventral process elongate, roughened apically. Forceps not greatly broadened apically (left and right of different shape in type); inner teeth very elongate. Anal segment asymmetrical apically; left apex produced ventrad. Aedeagus with very elongate subapical process; right basal portion of periandrium with slender elongate process. Anal segment of female broadly elliptical with either end truncate.

Male holotype, female allotype, and thirteen paratypes from "REAL DE ARRIBA, TEMASCALTEPEC, MEXICO," May 22, 1933 (Hinton & Usinger), CAS.

Abacus resembles any other medium sized oliarid but differs by the phallic structure as noted in the description.

Oliarus catus Caldwell, new species

Length, male 5.6 mm.; female 5.9 mm. Black over all with red carinae. Elytra whitish hyaline with brown veins.

Vertex short, broad, more apparent in female because the lateral margins are less elevated. Frons much widened apically, concave on either side of prominent median carina; clypeus strongly convex. Intermediate carinae of pronotum not reaching posterior margin. Lateral and intermediate carinae of mesonotum slightly arcuate, not prominent. Posttibiae each with one large spur and several small basal spurs.

Male pygofer with lateral margins acutely produced caudad on either side; medioventral process short, thick. Forceps elongate, broadened and recurved apically. Anal segment hood-like. Aedeagus without direct apical processes; periandrium produced into a very large lobe on either side ventrally; lobes acute apically, divergent.

Male holotype "CARR CYN. ARIZONA, HUACHUCA MTS.," June 23, 1932. Female allotype "Cave Crk. Arizona, Chiricahua Mts.," June 20, 1932 (J. O. Martin), CAS.

Differing from other oliarids by the phallic structure as noted in the description.

Oliarus retentus Caldwell, new species

Length, male 4.5 mm.; female 5.4 mm. General color black. Median facial carina and mesonotal carinae red in male. Intermediate carinae of mesonotum and space between intermediate and lateral carinae yellowish in female. Elytra whitish hyaline with yellow veins; apical cross veins broadly fuscous; punctations brown; stigma lightly embrowned.

Vertex elongate, narrow, acute apically. Basal fork of median facial carinae almost obsolete. Intermediate carinae of pronotum not reaching posterior margin though appearing to because of color. Intermediate carinae of mesonotum almost obsolete. Posttibiae with three preapical spurs diminishing in size toward base of tibia.

Male pygofer with lateral margins angularly produced caudad on either side; medioventral process short, triangular. Forceps long, slightly enlarged apically; apices recurved. Anal segment flap-like. Aedeagus with two apical and one subapical processes; periandrium with one long, straight process at right base and two curved processes at left apex.

Anal segment of female small, ovate, broader than long.

Male holotype, female allotype, and 11 paratypes from NOGALES, ARIZONA, September, 1906, (Koebele), CAS.

Differing from other oliarids by phallic details as noted in the description.

Oliarus rarus Caldwell, new species

Length, male 5.7 mm. Fuscous with exception of brown face, yellowish legs, orangish mesonotal tablet, and light carinae. Elytra whitish hyaline with yellowish veins punctate with black.

Vertex elongate; median carina present for three-fourths length; apical facets short. Intermediate carinae of pronotum not reaching posterior margin. Intermediate carinae of mesonotum strongly arcuate. Posttibiae each with one large and one medium preapical spur. Furcation of Sc and R at about center of elytron.

Male pygofer with lateral margins broadly produced caudad on either side; medioventral process elongate, broadly rounded apically, keeled ventrally. Forceps broadly spatulate apically; inner tooth highly developed and bifid on right forcep, small and single on left. Anal segment broad, flap-like. Aedeagus with one apical and two subapical processes; periandrium with long basal process on right projecting to left and a subapical process projecting straight caudad, a small subapical spur present dorsad projecting cephalad.

Male holotype from CERALBO ISLAND, GULF OF CALIFORNIA, June 8, 1921 (Chamberlin), CAS.

Differing from other oliarids by phallic characters as noted in the description.

Oliarus isolatus Caldwell, new species

Length, male 5 mm. Brownish fuscous with all cranial carinae and pronotal carinae light yellow; apex of mesonotum yellowish. Veins yellow becoming fuscous apically; punctations black, prominent; few light fuscous spots scattered over elytra.

Vertex narrow for full length, rounded rather than acute apically; lateral margins almost perpendicular. Intermediate carinae of mesonotum obsolete, median carina very fine. Fork of Sc and R in basal half of elytra.

Male pygofer with lateral margins greatly produced caudad on either side; medioventral process hemispherical, tipped with a small acute spur. Forceps short, stout, recurved apically. Anal segment hood-like. Aedeagus with one long apical process and two small subapical processes (one dorsal and one ventral). Periandrium with two large basal processes and two slender apical processes; no dorsal process present at apex.

Male holotype, from MARIA MADRE VILLAGE, TRES MARIAS ISLANDS, MEXICO, May 21, 1925 (Keifer), CAS.

Differing from most oliarids by the obsolete intermediate mesonotal carinae and from all others by the phallic characters as noted in the description.

Oliarus nanus Caldwell, new species

Length, male 4.5 mm. Black with cranial and pronotal carinae reddish-orange. Elytra slightly yellowed at base; veins brownish-yellow; punctations concolorous with veins.

Vertex very narrow, deep; facets very elongate. Frons elevated along median carina; clypeus flatter. Intermediate carinae of pronotum reaching posterior margin. Mesonotal carinae very fine. Posttibiae with one large preapical spur. Sc and R very long.

Male pygofer with opening flared; lateral margins notched on either side caudad; medioventral process short, stout. Forceps short, stout, recurved laterally and cephalad at apices in ventral aspect; with dorsal thumb-like projection in lateral aspect. Anal segment invert cup-shaped apically, apex split. Aedeagus with one long apical process at left; periandrium with one large bifurcate apical process at left, right base broadly lobate.

Male holotype from "REAL DE ARRIBA, TEMASCALTEPEC, MEXICO," May 23, 1933. Paratype (with tip of abdomen missing) same locality, May 21, 1933 (Hinton & Usinger), CAS.

Resembling *isolatus* but differing by the presence of intermediate mesonotal carinae and by phallic characters as noted in the description.

Oliarus aztecus Caldwell, new species

Length, male 5.8 mm.; female 6 mm. Black over all with dark orange carinae. Legs yellowish. Veins yellowish becoming fuscous apically, punctations scarcely embrowned.

Vertex narrow, trough-like, more acute in female than male. Face narrow, median carinae very prominent. Intermediate carinae of pronotum almost reaching posterior margin. Intermediate carinae of mesonotum little elevated, slightly nearer lateral carinae than to median. Posttibiae each with two large and several small preapical spurs, the latter near the base. Elytra narrow, elongate; punctations scarcely visible.

Male pygofer with lateral margins truncate caudad; medioventral process elongate. Forceps very elongated, greatly broadened apically, recurved; inner teeth elongate. Anal segment flap-like, straight, bifid apically. Aedeagus with three long and one short apical processes, a short process present at base of apical portion; periandrium with bifurcae apical process.

Male holotype, female allotype, and three paratypes from "TEJUPILCO, TEMASCALTEPEC, MEXICO," June 17, 1933 (Hinton & Usinger), CAS.

Differing from other oliarids by the phallic characters as noted in the description.

Oliarus bispinus Caldwell, new species

Length, male 4.4 mm. General appearance black; median frontal carina faintly orange; spots on vertex next to either eye white; pronotal carinae gray; tibiae and tarsi dusky yellow; elytra milky colored; veins brownish-yellow becoming fuscous apically.

Face greatly curved in profile. Vertex elongate; impressed on either side of short, basal, median carina. Intermediate carinae of pronotum not reaching posterior margin. Lateral and intermediate carinae of mesonotum very thin. Punctations on veins few, regular.

Male pygofer with lateral margins produced caudad, acute; medioventral process short, ovate. Forceps long, recurved, little expanded apically. Anal segment short, hood-like. Aedeagus without apical processes; periandrium with bifurcate process at dorsal apex in addition to three ventral processes.

Male holotype from CHISOS MTS., TEXAS, July 17, 1946 (D. J. & J. N. Knull), OSU.

Bispinus differs from the other oliarids by the bifurcate process on the dorsal surface of the periandrium in addition to other phallic characters as noted in the description.

Oliarus uncatus Caldwell, new species

Length, male 4.8 mm. Face light brown with yellowish carinae. Vertex and mesonotum black. Carinae of mesonotum orange; area between outer and intermediate carinae orange. Elytra milky with yellow veins becoming darkened apically.

Face evenly ovate; median carina prominent. Vertex narrow, trough-like. Intermediate carinae of mesonotum broken, irregular. Punctations on veins regular, not prominent; stigma long, narrow.

Male pygofer with lateral margins acute caudad; medioventral process long, slender. Forceps spatulate apically, slightly recurved, appearing coiled. Anal segment relatively short, hood-like. Aedeagus with one apical and one subapical process; periandrium with short spur dorsally; with three processes ventrally, left process broad and slightly bifid apically.

Male holotype from PRESCOTT N. F., ARIZONA, June 20, 1947 (D. J. & J. N. Knull), OSU.

Differing from other oliarids by the phallic characters as noted in the description.

Oliarus sylvaticus Caldwell, new species

Length, male 3.5 mm.; female 4 mm. General color black; all carinae brownish-yellow. Elytra whitish hyaline; veins black except costa; cross veins broadly fuscous; stigma in male yellow, black in female.

Face angulate in profile, strongly convex. Vertex about twice as long as broad, lateral margins parallel in basal two-thirds. Intermediate carinae of pronotum not reaching posterior margin. Median tablet of mesonotum broad, carinae equidistant apart. Punctations on veins close, evenly spaced, not prominent.

Male pygofer with lateral margins broadly rounded caudad; medioventral process short, acute. Forceps spatulate apically; apices appearing rectangular in ventral aspect. Anal segment flap-like. Aedeagus with three apical processes; periandrium produced into large plate-like process on left, right process thin; a long spine-like process present near dorsal apex.

Female valvulae very short, flat; anal segment small, rounded.

Male holotype and paratype, and female allotype from OAK GROVE, CALIFORNIA, June 3, 1946 (D. J. & J. N. Knull), OSU.

Differing from other oliarids by the phallic characters as noted in the description.

THE OCCURRENCE OF THE GENUS *STETHYNIUM* IN CALIFORNIA

(Hymenoptera: Mymaridae)

BY RICHARD L. DOUTT[1]

University of California Agricultural Experiment Station
Albany, California

The mymarid genus *Stethynium* has previously been represented in North America only by a single species (*faunum* Girault) from Illinois. The finding of *annulatum* n. sp. is the first record of the genus occurring in California. No host records are available for this group, but the species are presumed to be parasitic in the eggs of other insects.

Stethynium annulatum Doutt, new species

Readily distinguished from *faunum* and the European *triclavatum* by the antennal characters, particularly the relative lengths of the funicle segments. In addition the basal dilation of the caudal margin of the fore wing is not so pronounced as in *faunum* and *triclavatum*, and there are fewer lines of discal cilia. The general body color and the presence of circular concavities on the scape further separate *annulatum* from the only other known American species, *faunum*. The posterior wings are not broadened as in the Australian species, *peregrinum*.

Female. Length 0.62 mm. General body color dark brown, the head, thorax, and posterior two-thirds of abdomen concolorous. Basal third of abdomen yellow. Legs very pale yellow except for apical tarsal segments which are dusky. Scape honey yellow; pedicel and funicle pale yellow, the same as the legs; club dusky. Compound eyes and ocelli very deep red, appearing black in transmitted light. Wings hyaline.

Fore wings somewhat narrow for the genus; not densely ciliate and bearing 9-12 lines of discal cilia across widest portion. Longest marginal cilia slightly longer than distance across greatest wing width. Marginal cilia short at apex of fore wing (Fig. 1, c).

Posterior wings narrow (about as in the type species, *triclavatum*). Single row of discal cilia placed somewhat caudad of wing

[1]Junior Entomologist in the Experiment Station.

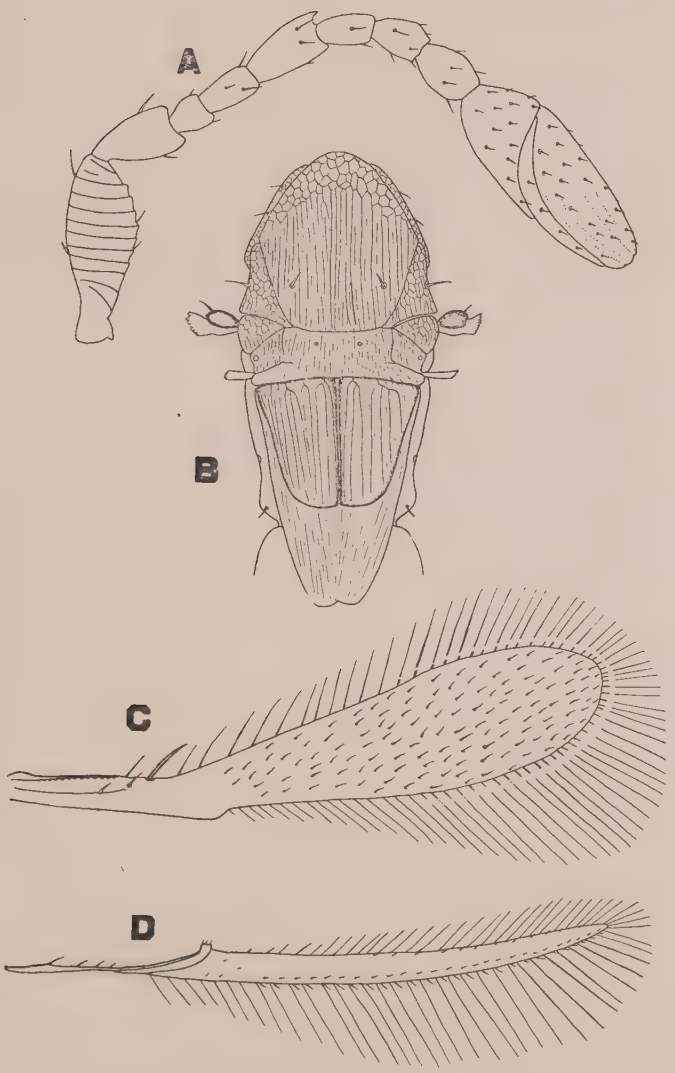

Fig. 1. *Stethynium annulatum*, n. sp. A. Antenna. B. Thorax, dorsal view. C. Fore wing. D. Posterior wing.

blade center. Longest marginal cilia approximately four times greatest wing width (Fig. 1, d).

Antennal scape with about 10 distinct circular concavities. The specific name, *annulatum*, is derived from the ringed appearance of the sclerotized ridged areas between the concavities. Scape equal in length to pedicel and first two funicle segments combined. Pedicel longer than broad, subequal to funicle 3, the longest segment of the funicle. Funicle 1 barely longer than wide, the smallest funicle segment. Funicle 2 rectangular. Joints 4, 5, and 6 subequal in length. Segment 6 subovate. Club indistinctly three segmented. Club segment 2 distinguishable only with careful magnification. The structure of the two distal club segments together with the elongate sensorial areas of the third segment give the club a lamellate appearance. Antennal characters shown in Fig. 1, a. Pubescence inconspicuous. Mandibles quadridentate.

Thorax subequal in length to abdomen. Mesoscutum with reticulate sculpturing in anterior portion becoming longitudinally striate posteriorly. Parapsidal sutures complete, parapsides reticulate. Each parapsis bearing a single seta. Scutum bearing two setae near parapsidal furrows. Axillae widely separated, reticulate. Scutellum longitudinally striate. Transscuttellar suture prominent. Metanotum with longitudinal median suture. Two distinct dorso-lateral scutellar areas present just caudad of axillae. Phragma extending into abdomen (Fig. 1, b).

Abdomen sessile, elongate, showing Anagrine affinities. Ovipositor and attendant valves exserted for a length equal to length of funicle segment 2.

Tarsi four segmented. Cephalic tibial spur bifid at apex, curved. Strigil present. Proximal segment of cephalic tarsi slightly longer than succeeding segment; distal 3 segments subequal in length.

Male. Unknown.

Described from five specimens mounted in balsam on individual slides. Holotype, female, collected by sweeping native vegetation at HECKER PASS near GILROY, CALIFORNIA, August 22, 1947 (R. L. Doutt). One female *paratype*, same locality, August 22, 1947 (R. L. Doutt). Two female *paratypes* same locality, September 17, 1947 (R. L. Doutt). One female *paratype* trapped on yellow "tanglefoot board" in orange tree, Peralta, California, August 25, 1946 (R. C. Dickson).

Type deposited in the collection of the Division of Biological Control, University of California. One paratype to be deposited in the collection of the California Academy of Sciences. One paratype to be deposited in the United States National Museum.

NEW SPECIES OF COLEOPTERA FROM WESTERN NORTH AMERICA

BY EDWIN C. VAN DYKE
California Academy of Sciences, San Francisco

Family Cicindelidae

Cicindela oregona navajoensis Van Dyke, new subspecies

Of the same general size and form as the usual *oregona* but conspicuously cupreous above, the pro-, meso-, and metapleurae brilliantly cupreous, the remainder of the ventral surface metallic green with a bluish tinge here and there; the elytral yellow markings all rather broad, especially the median which often has the oblique inner portion as broad as the outer transverse part, the humeral lunule generally broken and the apical lunule rarely complete. As extreme variants we may have the posterior portion of the humeral lunule connected with the outer portion of the median.

Holotype, male, allotype, female (Nos. 5864 and 5865, Mus. Calif. Acad. Sci., Ent.) and numerous designated paratypes from a series of forty specimens collected at Kayenta, 15 miles W N W, Arizona, June 17 and 24, 1933, and other dates in June, 1933, and at Betatakin and Nova Mt., July 13, 1933, all in Navajo County, Arizona. These were all collected by H. N. Hultgren of the Ansel F. Hall Expedition of 1933.

This subspecies resembles the race *guttifera* of *oregona* in having the pleurae cupreous whereas they are green in typical *oregona*. Superficially the cupreous upper surface contrasts with the usual chocolate brown of *oregona* as well as *guttifera* and marks it off as distinctly as does the brilliant color of the subspecies *maricopa*. In its color relationship to *oregona* it parallels *arizonica* as compared with *carthagena*.

Family Meloidae

Lytta nevadensis Van Dyke, new species

Upper surface glabrous, dull blue, antennae, mouthparts, tibiae and tarsi black, and with a small red frontal spot. Head quadrate behind antennae and slightly broader than long, smooth, shining and sparsely punctured. Antennae slightly longer than head and prothorax, third segment a bit more than twice as long as broad, segments 4-10 moniliform, gradually broader or more robust outwardly and all somewhat longer than broad, the eleventh fusiform

and about three times as long as broad. Pronotum a little narrower than head, sides rounded, narrowed in front; disc moderately convex, finely alutaceous and somewhat dull, with a feeble median longitudinal groove at most and with a few fine punctures, chiefly towards the sides. Elytra finely rugose and feebly shining. Legs slender, anterior tibiae of males with two spurs, middle tibiae of males much bowed and the outer spur of hind tibiae stouter than inner, broader and concave at tip. Fifth ventral segment of male truncate, sixth emarginate and pygidium rounded at apex. Length: male holotype 9 mm., female allotype 11 mm.

Holotype, male, allotype, female (Nos. 5866 and 5867, Mus. Calif. Acad. Sci., Ent.), and numerous designated paratypes from a series of thirty-nine specimens collected by myself, July 3, 1941, in KYLE CANYON of the CHARLESTON MTS. of southern NEVADA. Most were feeding on *Cowania stansburniana.*

This species is related to *stygica* (Lec.) and runs to that in Fall's key (Trans. Amer. Ent. Soc., XXVII, 1901, p. 299) but it is eminently distinct. The variable *stygica* in all its color phases is always more shining, generally much larger, *nevadensis* varying from 6-11 mm. in length whereas *stygica* ranges from 7-14 mm., with longer antennae, the individual segments conspicuously longer, the upper surface often more or less pilose and the middle tibiae of males less bowed. The small size and supopaqueness of *nevadensis* are its most evident features.

Lytta sonorae Van Dyke, new species

Small, robust, head and prothorax shining, elytra somewhat dull; orange-yellow with antennae, palpi, eyes, tarsi, claws excepted, four spots on pronotum and a broad vitta, variable in length, extending from behind humeri towards the apex of elytra, black. Head quadrate behind the antenna, broader than long and sparsely punctured. Antennae short, slightly longer than head and prothorax, third segment twice as long as broad, segments 4-10 moniliform, slightly broader outwardly except that in the male segments 4-6 are somewhat broader than seventh and eighth, the eleventh fusiform and about twice as long as broad. Pronotum narrower than head, companulate, smooth, sparsely and finely punctured, sparsely and finely pilose, and ornamented with four small black spots, two in the middle and one on each side, slightly in advance of the others. Elytra finely, densely rugose and clothed with a sparse, short pile. Legs moderately robust, anterior tibiae of males with two spurs, middle tibiae of males feebly bowed, and the inner spur of hind tibiae short and sharp, the outer longer, broader and concave at tip. Fifth ventral segment of males truncate, the sixth deeply emarginate. Length 8 mm.. breadth 3 mm.

Holotype, male, allotype, female (Nos. 5868 and 5869, Mus. Calif. Acad. Sci., Ent.), the latter somewhat imperfect, and eight paratypes, collected at Carbo, Sonora, Mexico, November 24, 1933, by H. S. Gentry and all in the Van Dyke collection of the California Academy of Sciences.

This species is closely related to *scitula* Champ., also from Mexico, but differs by being somewhat smaller, the head and pronotum being finely and sparsely punctured, not coarsely and densely punctured as in *scitula*, the elytra with but one black vitta to each elytron whereas in *scitula* there is both a submarginal and sutural black vitta and the males have the fourth and fifth antennal segments but little more robust than the following. The two species should be placed close to *Lytta biguttata* Lec. from our own Southwest though the latter has no vittae, merely a black subapical spot, and is much larger.

Pleurospasta mirabilis (Horn)

In the semiarid regions east of the Sierra Nevada mountains and extending from near Reno, Nevada, south to the Coachella and Imperial valleys of California and to southern Arizona, typical specimens of the above-named beetle may be found running over the desert sands. As defined by Horn in his original description, the most evident features are that the general color is "pale rufous, elytra pale yellowish," and "oblong, broader behind, humeri moderately prominent, margin reflexed, suture elevated, and with four strongly elevated costae on the disc of each elytron, extending from base nearly to apex," and with "four small brown spots at base, arranged in arc with convexity backwards, an irregular transverse band at middle interrupted by the costae, and a narrow subapical band." These characters will apply to most specimens found in the territory indicated above. Farther to the east, as in New Mexico, Texas and Old Mexico, another race exists. This as shown by two specimens which I have from Loving, New Mexico, collected May 11 and June 3, 1945, by J. W. MacSwain, one specimen from Pecos, Texas, collected May 15, 1927, by J. O. Martin, and two specimens which I have received on loan from the Chicago Natural History Museum from Nuevo Laredo, Tamaulipas, Mexico, June 14, 1941 (Seevers and Dybas), which have the dominant color of the elytra almost a pure white, the four basal spots reduced to two, the post median band red rather than brown and black spots placed here

and there especially on the anterior and posterior margin of the bar. The costae as they cross the band are joined by transverse costae forming an irregular reticulation throughout the area. In addition the apical band is much more extensive than in typical forms and the prothorax narrower and with the disc more distinctly bituberculate and pitted. In the "Biologia Centrali-Americana," the illustration is of this race.

This race I believe is worthy of a name, so I will designate it as **Pleurospasta mirabilis reticulata** Van Dyke, new subspecies, and indicate the LOVING, NEW MEXICO, specimen collected on June 3, 1945, as the holotype (No. 5870, Mus. Calif. Acad. Sci., Ent.), the other specimens as paratypes, two in the collection of the California Academy of Sciences, and the Mexican specimens returned to the Chicago Natural History Museum.

FAMILY SCARABAEIDAE

Aphodius inyoensis Van Dyke, new species

Of moderate size, nigropiceous, rufopiceous beneath, smooth and shining. Head without tubercles, rather evenly convex above, but little flattened laterally and with narow side margins, the disc finely, evenly granulate throughout, the clypeus with a broad emargination in front, bounded laterally by obtuse angles, sometimes by a distinct tooth, genae prominent, the sides oblique, more or less straight and divergent. Prothorax one-fifth broader than long, sides arcuate, narrowing behind, hind angles broadly rounded, base feebly arcuate and with sides narrowly margined, the margin fading out at hind angles; disc moderately convex, finely, densely punctured and with a few larger punctures irregularly scattered though most numerous laterally. Elytra elongate oval, one-fourth longer than broad, feebly narrowed towards base, humeri well rounded; disc convex, distinctly striate, the striae finely punctured, intervals flattened forwards, feebly convex apically and each interval with a row of small punctures near their margins and a few irregularly scattered between the rows; wings rundimentary. Beneath finely alutaceous, moderately coarsely punctured in front and finely punctured on the abdomen, the punctures mostly placed transversely along the margins of the sclerites. Mesosternum with an acute carina between the legs which is laterally bounded by well developed episternal carinae. Posterior femora finely sparsely punctured; the hind margin of the tibiae in fresh specimens fimbriate with short equal spinules; first segment of hind tarsi about equal in length to the two following. Length 6 mm., breadth 3 mm.

Holotype (No. 5871, Mus. Calif. Acad. Sci., Ent.) and numerous designated paratypes from a series of fifty specimens collected by

myself, from beneath cow manure, near Big Pine, Inyo County, Calif., March 27, 1937.

This species belongs in the cadaverinus group of *Aphodius* and according to the latest table of the group, that by Saylor (Proc. Biol. Soc. Wash., 53: 99-103, 1940) would run close to *washtuca* Robinson and *rugoclypeus* Hinton, both of which are definitely larger and more robust and with numerous coarse pronotal punctures. The distinctive features of *inyoensis* are the granulate head, the finely, densely punctured pronotum and the flattening of the elytral intervals with the double row of minute punctures. The gross pronotal punctation so evident in all the other members of the group is lacking here.

Aphodius fenyesi Van Dyke, new species

Of moderate size, somewhat elongate and convex, piceous above, legs, under side and portions of head rufous. Antennae and palpi pale. Head moderately convex, without tubercles but with front somewhat gibbous, the occiput rather coarsely but not closely punctured, the sides finely and sparsely punctured; the clypeus very finely, somewhat obscurely punctured, feebly and broadly emarginate in front, the angles at the sides of the emargination distinctly dentate, the sides explanate, margins oblique, the genae rather prominent and obtuse angled. Prothorax about one-third wider than long, as wide in front as behind, sides feebly arcuate, the margins broadly explanate, a feeble impression near the hind angles which are well rounded, the base feebly arcuate and without marginal line; the disc moderately convex, with coarse punctures rather numerous over the basal two-thirds, denser at sides, and the apical portion and a median longitudinal space very finely and sparsely punctured. Elytra a little narrower at base than prothorax, gradually wider posteriorly, humeri obtuse; disc with striae well impressed and finely, closely punctured, the intervals flattened in front, feebly convex apically and finely punctulate. Beneath, the mesosternum coarsely, densely punctured, the mesopleurae more finely punctured, and the abdomen alutaceous and rather shallowly, sparsely punctured, the mesosternum not carinate. Anterior tibiae smooth in front, strongly tridentate externally but not crenate above, the first tarsal segment shorter than second. Posterior femora sparsely punctate, the hind margins of the tibia fimbriate with unequal spinules; and the first segment of the hind tarsi almost equal to the three following. Length 8 mm., breadth 3.5 mm.

Holotype (No. 5872, Mus. Calif. Acad. Sci., Ent.) and one paratype, collected at Flagstaff, Arizona, by Dr. A. Fenyes and now in the Fenyes Collection at the California Academy of Sciences.

This specimen belongs in the subgenus *Platyderides* Schmidt and is apparently somewhat related to *depressiusculus* Schm. *(marginatus* Lec.). The distinctive characters are in the head, especially the clypeal emargination with its lateral dentate angles and the pronotum with base without margin and the disc with its numerous coarse punctures, simulating in this regard many members of the cadaverinus group rather than most of its associates in *Platyderides*.

Polyphylla nubila Van Dyke, new species

Short and robust, reddish-brown, head and pronotum generally darker, the palpi, antennae and legs rufous, head and pronotum clothed with long, silky, light brown pile, sparser on basal portion of pronotum; the elytra irregularly clouded with patches of elongate white scales densely placed and with single scales peppered over the intervening areas. Head coarsely, densely punctured; clypeus with reflexed margins, densely, shallowly punctured, sides straight, diverging forwards, the front margin transverse and feebly bimarginate and with outer angles well rounded; the antennae (males) with a club that is 5 mm. long, 1 mm. longer than head, 2 mm. wide distally, and very much arched, and the terminal segments of maxillary palpi fusiform and at least three times as long as broad. Prothorax convex, apex emarginate, sides subangulate, the margin entire in front, feebly crenulate behind, the hind margin broadly lobed, the disc rather coarsely, irregularly punctured, a moderate longitudinal sulcus at middle, concealed to a certain extent by the stripe of white scales, and a large irregular impression on each side, also ornamented with scales, also numerous scales near the lateral and posterior margins. Elytra one-third longer than broad, with the surface irregularly, shallowly punctured and rugose and shining where not covered with scales, the apices broadly rounded and sutural angles right-angled. Pygidium densely clothed with white scales mixed with fine, short hairs except for a longitudinal line at middle which is naked and finely, transversely rugose. Beneath, fore body densely clothed with long, silky, light fulvous pile, the abdomen with white scales more or less densely disposed over the surface, especially near the posterior margins of the sclerites. Fore tibiae with a blunt tooth, near apex in male (mere knob in two specimens). Length 22 mm., breadth 10 mm.

Holotype, male (No. 5879, Mus. Calif. Acad. Sci., Ent.) and three male paratypes, collected at light, at ATASCADERO, SAN LUIS OBISPO COUNTY, CALIF., May 23, 1946, by George S. Mansfield, and kindly presented by him to the Academy.

This species stands well apart among Pacific Coast species because of its irregular, blotch like markings. Its ornamentation is even more irregular than in *variolata* Hentz and more pronounced.

Polyphylla diffracta arida Van Dyke, new subspecies

Rather small, rufous, head and pronotum generally darker, the palpi, antennae and legs somewhat lighter in color, head and pronotum rather sparsely clothed with long, fulvous pile; the pronotum with the usual three scaly vittae well marked, the elytra with the sutural vitta narrow and generally complete, the two discal and lateral vittae always much interrupted, so much in fact that the usual striped appearance is to a great extent lost, the intermediate areas irregularly peppered with scales. Head coarsely, densely punctured; clypeus with reflexed margins, densely punctured though punctures generally concealed by densely placed scales, sides straight or feebly sinuate and divergent, the front margin transverse or vaguely bimarginate, with the outer angles well defined, blunt or feebly rounded at most; the antennae (males) with a club that is 4 mm. long, subequal in length with the head, 1 mm. wide distally and moderately arched, the terminal segment of maxillary palpi fusiform and about three times as long as broad. Prothorax convex, apex emarginate, sides subangulate, the margin entire in front, crenulate behind; the disc rather coarsely irregularly punctured, the median longitudinal sulcus and lateral impressions well marked and covered with densely placed scales, the rest of the area with scattered scales. A dense collar of long fulvous pile also projects from beneath the hind margin of prothorax as usual. Elytra 3 mm. longer than broad, with the surface irregularly shallowly punctured and rugose, the naked areas shining and the apices broadly rounded and sutural angles right-angled. Pygidium transversely rugose and with a uniform but not dense covering of elongated scales and fine pile. Beneath, the fore body densely clothed with long, fulvous pile, the abdomen irregularly covered with scales. Fore tibiae of males in general with two well developed lateral teeth (in about half of the specimens the upper tooth is abortive or absent). Tarsal claws all armed with a pronounced and acute tooth near base. Length 20 mm., breadth 9 mm.

Holotype, male (No. 5874, Mus. Calif. Acad. Sci., Ent.) and numerous designated paratypes from a series of twenty-two specimens, all males, collected at Duns Plc., Navajo Mt., alt. 5580 ft., San Juan County, Utah, by H. N. Hultgren.

When first examined, I was inclined to consider the above a distinct species but upon further study have come to believe that it is only an extreme type or desert phase of *diffracta* Casey; it is smaller, lighter in color, rufous as against reddish brown and has the elytral maculation as irregular as in *variolosa* Hentz whereas *diffracta* is quite regularly vittate in that regard. On the Ansel Hall Expedition, several quite typical *diffracta* were taken near Kayenta, Arizona, not such a great distance from the type locality of *arida*.

DISTRIBUTIONAL AND BIOLOGICAL NOTES ON THE SPECIES OF THE SUBGENUS MELANOPHILA OCCURRING IN WESTERN NORTH AMERICA

(Coleoptera: Buprestidae)

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Melanophila (*Melanophila*) constitutes a unique group of Buprestidae because adults of this subgenus are attracted to fire, smoke and acrid fumes, frequently in large numbers and often from considerable distances. As a result they are popularly known as smoke beetles. A number of biological observations have been made on various forms, but since the species have not been easily distinguished and their distribution not understood, many such observations have either gone unpublished, or have been made on incorrectly determined material. Thus many of the early distributional and biological records concerning *Melanophila* (*Melanophila*) are questionable or incorrect.

Obenberger (1928) and Sloop (1937) have done much to clarify the status of the species in this subgenus and it is now possible to add to the distributional and biological knowledge of this group, as well as to summarize and correct certain previous records.

The data used in this report were gathered from material in the collections of the California Academy of Sciences, the University of California and those of the writers.

MELANOPHILA (MELANOPHILA) CONSPUTA LeConte

Melanophila consputa LeConte, 1857, Rep. Pac. Explora., 12:44.

This species has been previously recorded from Oregon, California, and Arizona. However, it is apparently rather widely distributed over western North America, following the range of its host species of conifers. These hosts are recorded as *Pinus ponderosa, P. murrayana, P. radiata, P. torreyana, P. attenuata, P. contorta* and *Libocedrus decurrens.* Sloop (1937) reports a specimen "in the larval channel under bark of *Eucalyptus globulus,*" but this record has not since been confirmed. Specimens have been

examined from the following new or more exact localities: Chiloquin, Klamath County, Oregon, July 23, 1922 (F. C. Clark); Esmeralda County, Nevada, June 12, 1908 (F. W. Nunenmacher) and Cananea, Dist. Arizpe, Sonora, Mexico.

Burke (1919), Chamberlin (1924), Van Dyke (1926, 1928), Linsley (1933, 1943), and Keen (1938) record this species as being attracted to fires and smelters.

Melanophila (Melanophila) notata elegans Sloop

Melanophila notata elegans Sloop, 1937, Univ. Calif. Pub. Ent., 7(1):7.

This subspecies was described from specimens collected at Douglas, Arizona, which is located at the extreme southern border of the state. A specimen from Cananea, Dist. Arizpe, Sonora, Mexico, extends the range to the southwest for some 50 miles. Nothing is known of its host plants, but it is believed to breed in pines.

Melanophila (Melanophila) acuminata (De Geer)

Buprestis acuminata De Geer, 1774, Mem. Hist. Ins., 4:133.

Melanophila acuminata has had a number of species confused with it. It has now been established that *M. acuminata* is holarctic in its distribution, breeding only in coniferous trees such as pines, firs, and spruces. In western North America it ranges from Alaska at least as far south as Central California. Linsley's record (1933) from Douglas, Arizona, was based upon *M. occidentalis* Obenberger (see below).

Melanophila (Melanophila) occidentalis Obenberger

Melanophila occidentalis Obenberger, 1928, Archiv. Naturg. 92(A):209.

This species was described from material which was merely labeled "California," and has since been recorded more specifically from Orange County, California (Sloop, 1937), Southwestern Oregon (Beer, 1940), and Berkeley, California (Linsley, 1943). It appears, however, to occupy a rather wide range over western North America as may be seen from the following locality records:

Washington: Heartline, June 30, 1940 (H. P. Chandler).

Oregon: Klamath Falls, July 7, 1934 (Van Dyke); Grants Pass, June 2, 1939 (F. M. Beer).

Utah: Garfield, June 28, 1922 (Van Duzee).

California: Siskiyou County; McCloud, Siskiyou County, July 3, 1914 (Van Dyke), July 23, 1918; Castle Crags, Shasta County, July 19, 1921 (Van Dyke); Davis, September 19, 1930 (F. H. Wymore); Antioch, July, 1936 (E. S. Ross); Brentwood, July 28, 1936 (Van Dyke); Berkeley, September 27, 1921 (Van Duzee), November 21, 1911 (J. C. Bridwell); San Francisco, October, 1918, October 6, 1931 (J. A. Kusche); Carmel, October 25, 1915 (L. S. Slevin); Dos Palos, Merced County, July 10, 1946 (K. S. Hagen); Los Angeles County; Claremont, October 22, 1927 (T. Craig); Lytle Creek, San Bernardino County, June 8, 1928 (Van Dyke); Needles, June 12, 1940 (W. F. Barr); Herkey Creek, San Jacinto Mountains, June 20, 1940 (E. G. Linsley); Idyllwild, June 29, 1928 (Van Dyke); Indio (E. G. Linsley, J. W. MacSwain); Blythe, May 16, 1937 (M. A. Embury); June 22-25, 1946 (W. F. Barr, E. G. Linsley, J. W. MacSwain, R. F. Smith), August 24, 1946 (W. F. Barr); Ripley, Riverside County, July, 1946 (W. F. Barr); Palo Verde, Imperial County, August 17, 21, 1946 (W. F. Barr, P. D. Hurd); Poway, San Diego County (Blaisdell).

Arizona: Jerome (Bruder); Ehrenberg, June 17, 1946 (W. F. Barr, E. G. Linsley, J. W. MacSwain, R. F. Smith), Douglas, June 7, 1930 (E. G. Linsley); "Arizona" (O. Dietz).

Lower California: Five miles north of Mission San Vicente, September 20, 1941 (E. S. Ross and G. E. Bohart).

Sloop (1937) lists its host as "oak" and the specimen from Herkey Creek in the San Jacinto Mountains, Riverside County, California, was collected from *Quercus kelloggii*. Beer (1940) records *Quercus garryana, Q. californica* and *Arbutus menziesii* as additional hosts. Linsley (1943) has recorded the species on partially burned eucalyptus. Several of the specimens from Palo Verde, Imperial County, California, were swept from *Larrea glutinosa tridentata* and *Tamarix*. The specimens from Dos Palos, Merced County, California, and Ripley, Riverside County, California, were swept from alfalfa.

Apparently this is the only member of this subgenus known to breed regularly in broad-leaved trees and shrubs in western North America. This fact may explain some of the records of *Melanophila* (*Melanophila*) spp. from non-coniferous areas in this region. A factor correlated with the numerous hosts of *M. occidentalis* is the wide range this species occupies.

M. occidentalis was frequently observed in the Palo Verde Valley in southeastern California during the summer of 1946. On

June 21 a stockpile of creosoted railroad ties and poles in the town of Blythe caught fire and burned and smoldered for several hours during the afternoon. Large numbers of *M. occidentalis* were attracted to the area because of the fire and for the next few nights they were very abundant about lights in the town. At the extreme southern end of the valley, below Palo Verde, Imperial County, a number of specimens were taken at light on the nights of August 17 and 21. No known recent fires had occurred at this locality. Across the Colorado River at Ehrenberg, Arizona, examples were also occasionally taken at lights throughout the summer. The predominant trees and shrubs in this valley are *Tamarix, Acacia, Prosopsis, Parkinsonia, Larrea, Pluchea* and *Atriplex.*

Linsley (1933) has recorded this species (as *M. acuminata*) about lights at Douglas, Arizona, where it was attracted in considerable numbers by the fumes of a smelter plant.

M. occidentalis and *M. acuminata* are closely related. However, the general distribution and hosts of the two are quite distinct. *M. occidentalis* apparently occurs most commonly in southwestern United States although its range extends northward into the state of Washington; it breeds in broad-leaved trees and shrubs. *M. acuminata* occurs throughout the Holarctic Region and breeds in coniferous trees. The ranges of the two species overlap along the Pacific Coast from central California to Washington.

Melanophila (Melanophila) atropurpurea Say

Melanophila atropurpurea Say, 1836, Trans. Am. Philos. Soc. (2)11:213.

Horn (1882) records this species from "Oregon to Texas in the mountain regions," Linsley (1933) from the San Francisco Bay Region, Doane et al (1936) from Kansas to the Pacific States, and Sloop (1937) from Arizona, Texas and Utah. Horn and Van Dyke were confusing two and probably three species: the Kansas, Texas and Arizona(?) specimens were undoubtedly *M. atropurpurea* while the others from Oregon and California(?) were either *M. acuminata* or *M. occidentalis* or both. Linsley's record also involves one or both of these latter species. The only specimens of the true *M. atropurpurea* seen by the writers were from Oracle, Arizona (Oslar), Texas (O. Dietz), and Fort Sam Houston, Texas.

Sloop lists the hosts of this species as *Pinus ponderosa,* Douglas fir and true firs. However, none of these trees extend their range

into parts of Texas where *M. atropurpurea* is known to occur. It is reasonable to assume that this species has additional hosts and that some of the above records may be based on incorrectly determined material.

Doane et al (1936) list Monterey cypress, incense cedar, oak, and mountain mahogany as hosts. However, judging from the distribution of these plants two different species are probably involved, *M. acuminata* in the first two cases and *M. occidentalis* in the last.

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THE ORIENTAL SPECIES OF *OPLODONTHA*

(Diptera: Stratiomyidae)

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The genus *Oplodontha*[1] Rondani apparently has its center of distribution in tropical Africa, including Madagascar, where at least fifteen described species are known to occur. Outside this area, however, the genus is not well represented. Two species, *O. oasina* (Lindner) from North Africa and the widely distributed *O. viridula* (Fabricius) are recorded from the Palaearctic Region, but to date only one Oriental species, *O. rubrithorax* (Macquart), which is also known from tropical Africa, has been referred to this genus. A second Oriental species, *Stratiomys minuta* Fabricius, is, however, clearly congeneric with *O. rubrithorax*, and in this paper, I am describing a third, from the Philippine Islands.

Oplodontha was proposed by Rondani in 1863 for *Stratiomys viridula* Fabricius. The character on which the genus was based, namely, the absence of the "oblique venule (beyond the stigmatic venules) uniting the marginal and costal veins" seems to be a good one, provided that it is properly interpreted. The vein to which Rondani refers is R_{2+3}, if the "stigmatic venules" are interpreted as those forming the base and upper edge of the stigma; they cannot include the one closing the stigma (that is, R_{2+3}), since that vein is absent. Pleske[2] used the same interpretation (venis subcostali et radiali junctis), but Lindner[3], in adapting his key from Pleske's work was apparently confused by that author's use of the Schinerian system, although the resulting misstatement (sc und r_1 verschmolzen) was corrected in the diagnosis on page 84 ($r_{2,3}$ ist mit r_1 verschmolzen). In this connection, however, I question the correctness of Pleske's assumption that R_{2+3} is united with R_1; I think more probably that R_1 and Rs remain as two undivided veins, rather than that the anterior branch of Rs coalesces with R_1.

[1]The form *Hoplodonta*, as emended by Kertész, has been used by most authors. Nevertheless, it is better to use Rondani's original spelling, even though it is not so desirable from the standpoint of orthography.

[2]Ann. Mus. Zool. Acad. Sci. Russie, vol. 23, p. 336. 1922.

[3]Die Fliegen der Palaearktischen Region, vol. 18, pp. 80, 84. 1938.

Another error into which authors commonly fall is to consider the vein mentioned by Rondani as R_1. Although this vein, like R_{2+3}, is wanting, its absence is of no diagnostic value, whereas that of R_{2+3} seems to be.

Taken alone, this character is not a strong one; but the general wing pattern, along with other characters, is sufficiently distinct to be of generic importance. The following characters apply to all species known to me.

Genus OPLODONTHA Rondani

Flagellum of antenna six-segmented, the fifth segment minute and together with the sixth forming a short, blunt, style. Face protuberant. Eyes pilose or bare. Proboscis moderately elongated, when extended at least three-fourths head height, the labella rigid and slender. Scutellum semi-elliptical, with two distinct, though sometimes small, spines. Wing longer than abdomen; venation considerably reduced; vein Rs unbranched and distinctly bowed downward on its basal part, making the submarginal cell relatively broad; r-m sometimes wanting; discal cell sometimes wanting, when present small, its height less, usually considerably so, than the distance from its upper corner to the costal margin; vein M_3 wanting; veins M_1, M_2, and Cu_1 weak, often reduced to a stump and a fold, sometimes plainly evident throughout. Size usually small, most species being no longer than 6 mm.

KEY TO THE ORIENTAL SPECIES

1. All femora largely black; all tibiae prominently black-ringed; venter black, except for a large yellow area on the second segment and narrow yellow posterior margins on the following segments ..... *luzonensis*

–. At least front and middle tibiae entirely yellow; venter wholly yellow, or nearly so 2

2. Pleura without pale spots; scutellum wholly black; hind femur and tibia wholly yellow ..... *rubrithorax*

–. Pleura with conspicuous pale spots; scutellum yellow, except base; hind femur and tibia each with a black annulus ..... *minuta*

Eulalia exigua Lindner,[4] from Amboina, may belong to this genus as Lindner compares it with *rubrithorax* and *minuta*; however, his statement "D wohlentwickelt, mit zwei *m*-Asten" makes this disposition highly doubtful.

[4]Ann. Mag. Nat. Hist., ser. 10, vol. 20, pp. 379-380. 1937.

Oplodontha luzonensis James, new species

Female: Head chiefly yellow; a broad band on vertex, including ocellar triangle, another band above base of antennae, biarcuate on its upper border and attenuated laterally, but narrowly reaching each eye, and the occiput, except its broad orbits, black; facial prominence, a small spot on each side and sometimes connected with it, and the larger part of the oral margin, brownish to black. Front rather strongly convex, its sides almost parallel; at vertex very slightly less and at base of antennae very slightly greater than half head width. Occipital orbit of moderate breadth, shining, bare. Eyes with rather dense, short, black hair; pile of head short, erect, rather dense, uniformly pale. First and second antennal segments, flagellum excluding style, and style in ratio of 18: 10: 32: 4; first and second segments yellow, flagellum, including style, brownish. Proboscis brownish to black.

Mesonotum black; humerus bright yellow; supra-alar callus brownish yellow; pleura chiefly black, on each side with four callus-like yellow spots, located one below humerus, one on mesopleuron anterior to wing base, one on pteropleuron below wing base, and one on upper part of sternopleuron; scutellum yellow, its base broadly black; spines short, blunt, yellow. Pile of thorax erect, rather dense, whitish; considerable whitish tomentum on mesonotum.

Coxae and trochanters black; femora black, except apices; each tibia with apical half mainly black; legs otherwise yellow, the tarsi darkened somewhat apically. Wing hyaline; stronger veins yellow; discal cell present; vein r-m wanting; veins M_1, M_2, and Cu_1 developed only at base, continued by a mere fold; Cu_2 and 2nd A weak.

Abdomen dorsally black, the very narrow lateral and apical margin and a small triangle at each apical angle of segments two, three, and four yellow; venter black, the narrow lateral and apical margin, the narrow apices of segments three and four, and a large trapezoidal spot occupying about the median half of segment two, yellow. Pile of abdomen short, inconspicuous, wholly pale.

Length, 4.5 to 6 mm.

Male. Eyes briefly subcontiguous above base of antennae. Occipital orbit not developed. Head black, except a prominent yellow triangle adjacent to the eye on each side of and below the facial prominence. Pile of thorax and abdomen as in the female, but longer and more conspicuous.

Holotype, female, Mt. Makiling, Luzon, P. I. (Baker), U. S. National Museum, No. 58583. *Allotype*, male, same data. *Paratypes*, 6 females, 14 males, same data; 1 male, Los Baños, P. I. (Baker).

OPLODONTHA RUBRITHORAX (Macquart)

Odontomyia rubrithorax Macquart, Diptères exotiques nouveaux ou peu connus, vol. 1, pt. 1, p. 185, 1838; de Meijere, Tijd. v. Ent. vol. 1, p. 224, 1907; Brunetti, Rec. Indian Mus., vol. 1, p. 128, 1907; Brunetti, Fauna of British India, Diptera Brachycera, vol. 1, p. 67, 1920; Brunetti, Rec. Indian Mus., vol. 25, p. 128, 1923.

Odontomyia immaculata Brunetti, Rec. Indian Mus., vol. 1, p. 130, 1907.

Hoplodonta rubrithorax Lindner, Bul. Mus. royal d'Hist. Nat. Belgique, vol. 14, p. 24, 1938; James, Amer. Mus. Nov., No. 1088, p. 2, 1940.

This species shows considerable variation in the color of the legs; the front and middle femora typically have each a median black band, although the legs may be wholly yellow. The brassy to reddish pubescence of the thorax, which suggested the specific name to Macquart, is often obscure, and may be yellowish.

This species is widely distributed. Brunetti has recorded it from various parts of India, Ceylon, and Thailand, and Lindner has recorded it from the Belgian Congo. I have seen a number of specimens from Okinawa, Ryukyu Islands, May, 1945 (Richard Bohart); Mt. Makiling, Los Baños, Davao, and Biliran Is., Philippine Islands (Baker); and Bantar, Gebang, Java (Bryant and Palmer).

OPLODONTHA MINUTA (Fabricius), new combination

Stratiomys minuta Fabricius, Entomologia Systematica, vol. 4, p. 268, 1794; Systema Antliatorum, p. 86, 1805; Wiedemann, Aussereuropaische Zweiflügelige Insekten, vol. 2, p. 74, 1830.

Stratiomys pusilla Fabricius, Entomologia Systematica, vol. 4, p. 271, 1794; Systema Antliatorum, p. 89, 1805; Wiedemann, Aussereuropaische Zweiflügelige Insekten, vol. 2, p. 75, 1830.

Odontomyia minuta Brunetti, Rec. Indian Mus., vol. 1, p. 126, 1907; Fauna of British India, Diptera, Brachycera, vol. 1, p. 65, 1920; Rec. Indian Mus., vol. 25, p. 124, 1923.

Odontomyia pusilla Brunetti, Rec. Indian Mus., vol. 1, p. 128, note, 1907.

Odontomyia ochracea Brunetti, Rec. Indian Mus., vol. 1, p. 129, 1907.

Odontomyia submutica Brunetti, Rec. Indian Mus., vol. 1, p. 130, 1907.

Oxycera indica Brunetti, Rec. Indian Mus., vol. 1, p. 119, 1907.

This species, according to Brunetti, is very widely distributed in India, and is extremely variable in the abdominal markings, which range from almost wholly yellow to almost wholly black.

A NEW SUBSPECIES OF MELITAEA
(Lepidoptera)

BY ROBERT C. WIND
Livermore, California

Discovery of a new subspecies of *Melitaea leanira* (F. & F.) was made by the author during a collecting trip to the Sierra in 1930. The butterfly was very local and several subsequent trips had to be made to obtain even a small series. In June, 1945, the author and Mr. T. W. Davies of Oakland visited Strawberry Lake, Tuolumne County, and managed to net a small series.

I take pleasure in naming this new subspecies after Mr. Davies.

Melitaea leanira daviesi Wind, new subspecies

Male. Fore wing ground color dark brown. Apical area extending over one-third of the wing bright orange russett, inner costal margin also bright orange russett. Hind wing as in *leanira* but with orange russett areas slightly more extended. *Female* as in male but with all colors brighter and slightly more extended. Beneath with black transverse bands more heavily black.

Holotype, male, Strawberry Lake, Tuolumne County, California, el. 5500 ft., June 26, 1945, and allotype, female, Strawberry Lake, Tuolumne County, California, el. 5500 ft., June 23, 1945, and eight male and eight female paratypes from the same locality and dates, also collected by Mr. Davies and the author.

For easy identification, I offer the following notes: *daviesi* is intermediate in coloring between *leanira* (F. & F.) and *wrighti* (Edw.). *Leanira* has both fore and hind wings of a dark black brown aspect, while *wrighti* has considerable orange russett on both fore and hind wings. *Daviesi* can be distinguished easily from these two species by the bright orange russett fore wings and the very dark black brown hind wings.

The types and some of the paratypes will be deposited in the California Academy of Sciences and elsewhere, while the balance of the paratypes will remain in the collections of Mr. Davies and the author.

THYSANOPTERA FROM NEW GUINEA, THE PHILIPPINE ISLANDS AND THE MALAY PENINSULA

BY DUDLEY MOULTON
Redwood City, California

This paper is presented as a partial report on the collections of Thysanoptera made by Dr. E. S. Ross in New Guinea and the Philippine Islands during 1944 and 1945 while serving in the Army. Most of the specimens were obtained on or under the bark of decomposing trees in rain forest areas. These collections are rich in material and the writer wishes to express his deep appreciation to Dr. Ross for the opportunity of examining them. There is also included the description of a new species from the Malay Peninsula which has been in the author's collection for some time. Holotypes and allotypes of the new species, except as indicated, are deposited in the California Academy of Sciences. The numbers following records of specimens refer to slide numbers in the Moulton Collection.

Family PHLAEOTHRIPIDAE Uzel

Tribe HOPLOTHRIPINI Priesner

Genus Agnostothrips Moulton, new genus

Body moderately stout, prothorax and fore legs heavy. Head approximately 0.33 longer than wide, flattened and not produced in front of eyes; with a distinct emargination between eyes and cheeks; cheeks slightly swollen behind eyes and then gradually reduced to base of head, roughened and bearing several small warts set with short spines; back of head faintly but distinctly reticulate; eyes prominent, semi-protruding, with numerous small facets; ocelli present; with one pair of long postoculars placed well back from eyes and near side margins of head. Antennae approximate at base, 7-segmented, 7 with a partial suture, segment 3 with three long sense cones. Mouth cone broad and strong, extending across prosternum, with pointed tip.

Prothorax heavy, 0.85 as long as head, with incomplete median thickening, sutures complete; all normal setae present, long, with pointed tips; fore legs strong, fore tarsus with a stout tooth; middle and hind femora also reasonably enlarged; wings with parallel sides, double fringes present. Abdomen normal, terga apparently

without sigmoid setae; tube approximately 0.75 as long as head, with parallel sides in basal two-thirds and reduced gradually in apical third; setae on segments 9 and 10 long.

Genotype: *Agnostothrips semiflavus*, n. sp.

This new genus is most closely related to *Symphyothrips* Hood and Williams but in *Symphyothrips* the cheeks are nearly smooth, without warts, the prothorax is relatively shorter, the tube shorter and shaped differently, also the third antennal segment has two sense cones.

Agnostothrips semiflavus Moulton, new species

Female: Prevailing color brownish yellow, head mostly yellow through the middle, darkened with brown at sides, prothorax more deeply shaded with brown, fore legs brownish yellow, middle and hind femora blackish brown, middle and hind tibiae and tarsi clear yellow; wings clear; antennal segments 1-4 colored like the head, 3 and 4 darkened apically and at sides, 5-7 blackish brown.

With characters as given for the genus; fore wings with 25 double fringe hairs.

Total length 3.8 mm.; head length 0.485 mm., width across cheeks 0.352 mm.; prothorax length 0.411 mm., width 0.602 mm.; pterothorax width 0.573 mm.; tube length 0.352 mm., width at base 0.117 mm. Antennal segments, length (width), III, 156 (66); IV, 146 (56); V, 120 (50); VI, 100; VII, 103 microns, total length 0.808 mm.; length of setae: postoculars 166, on anterior margin of prothorax 100, anterior angles 110, midlateral 156, outer on posterior angles 123, inner 133; on ninth abdominal segment 294, at end of tube 266 microns.

Type material and locality: holotype, female, No. 5879 (Calif. Acad. Sci., Ent.) taken at MAFFIN BAY, DUTCH NEW GUINEA, in June, 1944, by E. S. Ross (5657).

Macrophthalmothrips flavafemora Moulton, new species

Female: Prevailing color brown; ocellar area, median portion of head behind eyes, abdominal segments 8-10 and all coxae black, sides of head and prothorax lighter, abdominal segments 2-7 each with a median dark blotch which extends to sides along anterior margin, otherwise mostly yellow; all femora yellow, middle and hind femora with a faint brownish shading in the middle, fore tibiae yellow, middle and hind tibiae yellow but each with a darkened band in the middle; antennal segments 1-3 yellow, 4-6 gradually shading darker but yellowish in basal portions, 7 and 8 blackish brown; wings nearly clear.

With all of the distinct characters of the genus; fore wings with 10 double fringe hairs.

Total length 2.27 mm.; head length 0.308 mm., width 0.191 mm.; prothorax length 0.191 mm., width 0.264 mm.; pterothorax width 0.338 mm.; tube length 0.147 mm., width at base 0.073 mm. Antennal segments length (width), III, 93 (26); IV, 76 (33); V, 43 (26); VI, 56 (23); VII, 33; VIII, 23 microns, total 0.426 mm.

Type material and locality: holotype, female, No. 5880 (Calif. Acad. Sci., Ent.), and one female paratype, taken on bark of a fallen tree, FINSCHHAFEN, NEW GUINEA, 1944, by E. S. Ross (5652, 5657).

This species is distinctive in having all femora clear yellow. The only other known species with all yellow femora, *williamsi* Hood, from Trinidad, has a narrower darkened band on middle and hind tibiae and the antennae are nearly white with segment 2 at the sides, all of 5 except pedicel and 7 and 8 dark brown.

Tribe HAPLOTHRIPINI Priesner

Dolichothrips fuscipes Moulton, new species

Female: Color blackish brown except apical third of antennal segment 2, all of 3, fore tibiae and tarsi, which are brownish yellow; wings and setae clear.

Head 0.4 longer than wide, with straight cheeks, weakly reduced posteriorly; eyes moderately large, sub-ovate; postoculars long, pointed; antennae 0.6 longer than head, segment 3 with two sense cones; mouth cone reaching across prosternum, pointed; prothorax reasonably small, with an incomplete median thickening, all normal setae present, these long, pointed; wings narrowed in the middle, fore pair with 26-29 double fringe hairs; tube slightly longer than head, with straight sides, reduced gradually to apical end.

Total length 3.4 mm. with abdomen distended; head length 0.367 mm., width 0.259 mm.; prothorax length 0.19 mm., width 0.38 mm.; pterothorax width 0.47 mm.; tube length 0.41 mm., width at base 0.132 mm. Antennal segments length (width): III, 116 (46); IV, 120 (46); V, 110 (36); VI, 80 (33); VII, 66; VIII, 53 microns, total 0.676 mm.; length of setae, postoculars 161, on anterior margin of prothorax 103, anterior angles 83, midlateral 110, outer on posterior angles 156 microns.

Male: Similar in form and color to the female but with larger fore femora and fore tarsus with a short triangular tooth.

Type material and locality: holotype, female, No. 5881 (Calif. Acad. Sci., Ent.), and 14 female paratypes, allotype, and males, No. 5882 (Calif. Acad. Sci., Ent.), and 8 male paratypes, taken

at Maffin Bay and Finschhafen, New Guinea, during April, May, August and September, 1944, by E. S. Ross (5652, 5654, 5659, 5663 and 5666).

This species belongs in that group having dark brown middle and hind legs and is distinctive in its larger size, the greater number of double fringe hairs on fore wings and the relatively long tube.

Tribe Phlaeothripini Priesner

Phlaeothrips claratibia Moulton

This species was described from a single male specimen taken at Kipapa, Oahu, T. H. (Proc. Haw. Ent. Soc., 9, 3, 414, 1937), and now the female may be described as follows: general color almost identical with the male but somewhat darker; as in the male, the abdomen is nearly clear yellow with only the three terminal segments darkened, also all tibiae and tarsi are clear yellow; fore wings with 10 double fringe hairs. One specimen taken on bark, April 16, 1944, at Finshhafen (5652).

The only other species of *Phlaeothrips* known from New Guinea, *P. spinipes* Bagnall, has a relatively longer head with stronger spines and the fore femora have strong spines on the outside near the base, also antennal segments 3-8 are clear yellow.

Genus Ecacanthothrips Bagnall

This genus is richly represented in these collections from New Guinea and the following species, including two which are new, were found.

Ecacanthothrips bagnalli Priesner

Three females and two males taken on bark, April 16, 1944, by E. S Ross. These appear to be true to species as given in the description by Dr. Priesner (5652). There are two other series taken at Maffin Bay, in September, 1944 (5654), and in August (5659), which should probably be set up as a new variety due to the prevailing brown coloring of middle and hind tibiae, otherwise they are like the species.

Ecacanthothrips sanguineus Bagnall

Found in the 5654 series.

ECACANTHOTHRIPS COXALIS Bagnall

Represented by five females and three males in the same series, along with *coxalis* var. *philippinensis* Priesner.

Ecacanthothrips leai Moulton, new species

Female: Color brown, with sides of head, second antennal segment and margins of all femora blackish brown, fore tibiae brownish yellow, lighter apically, these darker than middle and hind tibiae which are clear yellow, antennal segments 3-8 grayish brown, bases of 4 and 5 somewhat lighter, fore wings only faintly washed with light brownish gray.

Head short, relatively broad, only 0.2 longer than width across cheeks; cheeks broadened immediately behind eyes, roughened, with two or three minute spines on either side, these placed on barely visible warts; postocular setae long and like other prominent setae with dilated tips; prothorax normal, with all normal setae well developed; pterothorax approximately as wide as width across fore coxae; tube short, rather broad, 0.7 as long as head. Antennal segment 4 longer than segment 3, this with a single row of 12 sense cones; fore femora enlarged, fore tibiae smooth, fore tarsus with a narrow, pointed tooth; fore wings with 10 double fringe hairs.

Total length 1.85 mm.; head length 0.28 mm., width 0.235 mm.; prothorax length 0.16 mm., width 0.352 mm.; pterothorax width 0.382 mm., tube length 0.22 mm., width at base 0.073 mm. Antennal segments, length (width); III, 83 (46); IV, 90 (43); V, 83 (33); VI, (66); VII, 46; VIII, 36 microns. Length of setae, postoculars 113, on anterior margin of prothorax 66, anterior angles 106, midlaterals 93, outer on posterior angles 100, inner 140 microns.

Type material and locality: holotype, female, taken at KUALA LUMPUR, MALAY PENINSULA, by A. M. Lea (No. 3421). Deposited in Moulton Collection.

This species resembles *E. crassiceps* Karny in general form but the fore femora are unarmed; it differs from *E. guineaensis*, new species, in its shorter and broader head, the fourth antennal segment longer than the third and in the darker colored antennae.

Ecacanthothrips guineaensis Moulton, new species

Female: Color blackish brown including antennal segments 1 and 2, and all femora except apical ends which are cleared to yellow; tibiae and tarsi clear yellow; antennal segments 3-5 brownish yellow, cleared to yellow at bases, 6-8 brown with 6 lighter at base; fore wings nearly clear, only faintly washed with light grayish brown.

Head 0.33 longer than width across cheeks, constricted neck-like at base, cheeks roughened, with two or three small cheek spines placed on inconspicuous warts; eyes large, with a distinct emargination at juncture with cheeks, these abruptly wider than width across eyes; postoculars prominent and like other body setae, with dilated tips; prothorax normal for the genus, with all regular setae; abdomen normal, terga 2-7 each with two pairs of sigmoid setae; tube short, approximately 0.6 as long as head, with straight sides. Antennal segment 3 with a single row of ten sense cones; fore femora enlarged, unarmed, fore tibiae unarmed and with almost smooth inner surface, fore tarsus with a short triangular tooth; fore wings moderately slender, with 12-16 double fringe hairs.

Total length 2.45 mm.; head length 0.294 mm., width across cheeks 0.22 mm.; prothorax length 0.147 mm., width 0.323 mm.; pterothorax width 0.367 mm.; tube length 0.176 mm., width at base 0.073 mm. Antennal segments, length (width): III, 106 (50); IV, 100 (43); V, 93 (33); VI, 90 (30); VII, 80; VIII, 40 microns; setae: postoculars 93; on anterior margin of prothorax 53, anterior angles 80, midlateral 50, inner on posterior angles 100, outer 60 microns.

Type material and locality: holotype, female, No. 5883 (Calif. Acad. Sci., Ent.), and two paratype females, taken on bark, April 16, 1944, by E. S. Ross at Finschhafen, New Guinea (No. 5652).

This species is distinctive with its unarmed fore femora, smooth fore tibiae and almost obsolete cheek warts, these being small and inconspicuous. *E. inernis* Buffa, also from New Guinea, has antennal segments 3-8 clear yellow; *E. inarmatus* Kurosawa has brown middle and hind legs; *E. bagnalli* Priesner has the fourth antennal segment longer than the third.

Subfamily Megathripinae Priesner

Tribe Megathripini Priesner

Bactrothrips (Bactridothrips) guineaensis Moulton, new species

Male: Color dark brown, abdomen mostly black; antennal segments 1 and 2 blackish brown, 3 and 4 grayish yellow with apical half of enlarged portion brown, 5 light brown with swollen end dark brown (other segments broken off) all femora blackish brown, somewhat lighter at bases, fore tibiae mostly yellow, shaded at sides, middle and hind tibiae like femora but yellowish in apical third, all tarsi yellow; wings washed with brown, darker along margins, cleared in apical fourth, median lines dark brown.

Head produced in front of eyes and including this process, 2.67 times as long as width at base; eyes prominent, with a slight emar-

gination at union with cheeks, these narrowed in median portion of head and widened again before joining with collar at base; anterior ocellus placed much farther in front of posterior ocelli than these are separated from each other; a pair of anteocellar setae, 160 microns in length, placed on a line midway between the anterior and posterior ocelli; postocellar setae (60 microns), placed midway between posterior ocelli and a line connecting posterior margins of eyes; first pair of postoculars small (40 microns), placed 23 microns behind eyes and 96 microns apart, second pair long (133 microns), placed 76 microns behind fore pair and 93 microns apart; a pair of cheek spines immediately behind eyes, these short, with blunt tips and two or three weak spines on either side near base of head. Antenna normal for the genus, fore wings with 48 double fringe hairs. Abdominal segment 6 with a pair of horn-like appendages, 0.514 microns in length, those on segments 7 and 8 about 88 microns in length. Tube long and slender, approximately eight times longer than width at base, clothed with numerous hairs standing up at about 45°.

Total length 6.75 mm.; head length 0.69 mm., width across eyes 0.28 mm., across lower cheeks 0.264 mm.; prothorax length 0.235 mm., width 0.47 mm.; pterothorax width 0.78 mm.; tube length 1.17 mm., width at base 0.16 mm.; antennal segments, length (width): III, 470 (50); IV, 367 (50); V, 338 (43); other segments missing.

Type material and locality: holotype, male, No. 5884 (Calif. Acad. Sci. Ent.), taken May 7, at FINSCHHAFEN, NEW GUINEA (5667).

This species is close to *B. furcatus* Priesner from the Belgian Congo, but this species is larger and the wings are clearer with a dark median line which diffuses at its end into a brown colored area while in the new species the fore wings are strongly colored brown with lighter colored areas between the sides and the median streak.

Tribe COMPSOTHRIPINI Priesner

RHAEBOTHRIPS LATIVENTRIS Karny

One male specimen taken in May, 1944, at Finschhafen, (5666).

MACROTHRIPS PAPUENSIS Bagnall

Mr. R. S. Bagnall described three species in this genus, *papuensis*, *intermedia* and *dubius*, all from New Guinea, (Ann. Mag. Nat. Hist., 8, 1, 359-361, 1908; Trans. Nat. Hist. Soc. Northumberland, 3, 1, 187-189, 1908). The material available to Mr. Bagnall con-

sisted of only a few specimens. The present collections made by Mr. Ross in New Guinea include numerous specimens of all the species erected by Mr. Bagnall and all of the specimens which correspond to his *papuensis* are males while all of those which correspond to *intermedia* and *dubius* are females and we have concluded that *intermedia* is the female of *papuensis*. These specimens which could be referred to Mr. Bagnall's *dubius* seem to be smaller and weaker forms of *intermedia*. Characters which were used to differentiate between the two species, the fore coxal projection, the inner tooth of the fore femora, position of the posterior ocelli as well as the teeth on the fore tibia show a blending variation between the stronger and larger *intermedia* and the smaller *dubius* but further material should be studied before including *dubius* also as one of the female forms of *papuensis* (5651, 5652, 5653, 5654).

MACHATOTHRIPS BIUNCINATUS Bagnall

Four females and 2 males taken April 16, 1944, at Finschhafen (5652).

MACHATOTHRIPS ARTOCARPI Moulton

This species was collected in great numbers, both male and female, at Maffin Bay, in August and September, 1944 (5654, 5659, 5652, 5653).

Machatothrips quadrudentatus Moulton, new species

Female: Color blackish brown, apical half of antennal segment 2, all of 3, also all tarsi brownish yellow; wings nearly clear at base and tip, brown through the middle and with a heavy brown line from near base to middle; prominent spines on head blackish brown, postoculars and setae on sides and end of abdomen clear yellow.

Head a little less than 0.5 times longer than wide, weakly narrowed behind eyes and at base; anteocellar setae prominent, approximately half as long as postoculars, the second pair of postoculars reduced to minor setae; with three or four strong genal spines on either side. Prothorax normal, with an incomplete median thickening, all normal setae present. Abdominal terga 2-7 each with a pair of sigmoid setae near posterior margin; tube with straight sides, narrowed from base to tip, approximately 0.1 times longer than head. Antennae normal for the genus, segment 3 less than three times as long as its greatest width and shorter than segment 4,

3 with two and 4 with four sense cones; segment 8 constricted at base and shorter than 7; legs with thickened fore femora, these with four teeth on the inside, the first largest, placed just beyond the middle, the other three reduced gradually; fore tarsus with a stout triangular tooth; fore wings with 52 double fringe hairs.

Total length 3.85 mm.; head length 0.411 mm., width 0.279 mm.; prothorax length 0.205 mm., width 0.470 mm.; pterothorax width 0.617 mm.; tube length 0.441 mm., width at base 0.147 mm. Antennal segments, length (width : III, 143 (50); IV, 160 (50); V, 143 (46); VI, 93 (33); VII, 60 (30); VIII, 56 microns, total 0.779 mm.

Type material and locality: holotype male, No. 5885 (Calif. Acad. Sci., Ent.), taken in May, 1944, FINSCHHAFEN, NEW GUINEA (5666).

This species is most closely related to *M. brevis* Bagnall which however has a much shorter head, this being only slightly longer than wide and with straight cheeks, antennal segments 7 and 8 are closely joined and the fore wings have 30 double fringe hairs. In this new species the head is relatively longer, antennal segment 8 is constricted at the base and fore wings have 52 double fringe hairs.

DINOTHRIPS SUMATRENSIS Bagnall

This species is richly represented in these collections and is apparently one of the most common thrips in New Guinea. The specimens show many variations in size and the number of double fringe hairs on fore wings, some are much larger than those in my collection from India and the Malay Peninsula but there seems to be no single character that could be used to separate them even as a variety of the species (5651, 5652, 5654).

DINOTHRIPS MONODON Karny

Six males and one female, taken on bark of a fallen tree at San Jose, Mindoro, in the Philippine Islands (5655).

DINOTHRIPS JACOBSONI Karny

Nine males taken along with *D. monodon* Karny on bark of a fallen tree at San Jose, Mindoro, Philippine Islands (5655).

MECYNOTHRIPS WALLACEI Bagnall

One female taken on bark of a fallen tree April 12, 1944, at Finschhafen (5651).

EMPIMORPHA GENEATIS MELANDER, A BALLOON FLY FROM CALIFORNIA, WITH A CHEMICAL EXAMINATION OF ITS BALLOONS

(Diptera: Empididae)

BY EDWARD L. KESSEL AND JOSEPH V. KARABINOS
University of San Francisco

On several occasions during March, 1946, a number of conspicuous white objects which glistened in the morning sunshine were observed zigzagging back and forth through the air in small groups in the immediate vicinity of some Monterey pines *(Pinus radiata* Don) at Mill Valley, California. Scrutiny of the scintillating white objects from the ground revealed that they were carried by inconspicuous black insects which were difficult to observe closely or capture because they were flying at an altitude of 15 or 20 feet. Only by tying the net handle to a sturdy surf-casting rod and then mounting the top of a 6-foot stepladder was it possible to bring any of the specimens to net. They proved to be male flies belonging to the family Empididae and the white object which each carried was a delicate, frothy, balloon-like structure which invariably had a minute dipteran or hymenopteran adhering to its anterior surface. The flies were never numerous, but persistent collecting during the 1946 season resulted in the capture of about 30 of them, each with its balloon and prey.

Most of the specimens taken in 1946 were deposited in the collections of the University of San Francisco and the California Academy of Sciences, but three of them were sent to Dr. A. L. Melander who kindly identified them as *Empimorpha geneatis*, a species which he had described (Melander, 1902) from a single specimen collected by Baron somewhere in California. This holotype, a male apparently taken without a balloon, is now in the American Museum of Natural History. There seem to be no reports of further captures of this insect.

Inasmuch as during the 1946 season all the balloon flies possible were captured for museum specimens without much attempt to

observe their habits, little of interest concerning the biology of the species was learned at that time. It was resolved, therefore, to carry on a biological investigation if and when the flies returned in 1947. In the meantime a survey of the literature brought to light the following facts which are of interest in connection with other species of Empididae known to carry balloons or comparable structures.

HISTORY

The first mention in the literature of the balloon-making habit is to be found in the observations of Osten-Sacken (1877). During August, while visiting in the Swiss Alps, he had observed the air dances of a species which later was named *Hilara sartor* Becker. Between 9 and 10 o'clock each morning he noticed small swarms of this insect dancing in the well-known zigzag style among the sunbeams which penetrated the dense shadow of the fir forest. What attracted his attention to the flies was the brilliant white or silvery reflection which flashed each time one of the insects penetrated the sunbeam. He caught one of the specimens and found to his astonishment that it was an inconspicuous dull-colored fly, much smaller than he had anticipated. It was then that he noticed the white film-like balloon on the gauze of his net. It was so light that the slightest breath carried it away. As he caught specimen after specimen with the same results, it became apparent that the silvery sheen and larger apparent size of the flies were both caused by the packets of sparkling white tissue which they carried.

A number of entomologists studed *H. sartor* in the years that followed and there ensued a lively conflict of claims relative to the nature, function, and position of its balloons. Becker (1888) concluded that the males carry the balloons on their backs and that they serve as decorations to attract the attention of the females. Mik (1888) insisted that the flies carry the packets below their bodies where they are suspended by the legs. He advanced the idea that these somewhat flattened silken objects are used by the males as aeronautical surfboards. Handlirsch (1889) followed with a detailed study of the balloons during which he made some chemical tests. He found that they did not melt when warmed and were not dissolved by ether, benzol, or carbon bisulfide, although they were soluble in warm medium-concentrated potassium hydroxide, cold concentrated sulfuric acid, and in concentrated hydrochloric acid. Verhoff (1894) advanced the theory that the balloons, flashing in the sun-

light and never containing prey, served as warnings to predaceous insects and birds.

Meanwhile it had been discovered by Girschner (1889) and Mik (1894) that several other kinds of *Hilara* also carry glistening white objects in their aerial dances, balloon-shaped structures composed of definite silken threads which frequently held struggling prey. Some species use microdipterans exclusively whereas others utilize trichopterans and psocids as well. Hamm (appendix to Eltringham, 1928) added yet other species of *Hilara* to the list of those forms which bind they prey with silken threads and ascertained that one member of the genus, *H. maura* Fabricius, carries two quite distinct types of nuptial balloons. The common variety consists of the usual silken threads and ordinarily encloses prey, although the prey is sometimes replaced by a vegetable fragment and in rare instances the balloon is entirely empty. Hamm found the second type on only one occasion; numerous males and mated pairs were found carrying these balloons which consisted of sticky globules instead of silken threads. Prey was lacking in every case. Eltringham (1928), in discussing the material of these globules says, "So permanent are its qualities that the examples mounted on cards 15 years ago are still as viscid as when first obtained." He adds that he found them to be soluble in water, rather slowly so in xylol, but insoluble in alcohol, ether, or chloroform. Hamm and Eltringham both suspected that the flies obtained these globules from some external source, possibly honeydew secretions.

Melander (1940) describes the aerial dances of *Hilara granditarsis* Curran, the first American species of the genus found to be a balloon maker. In Alberta during July he observed specimens of this fly dancing in small groups of 4 to 8 individuals among the spruce trees, a dozen feet or so above the ground. Some of the flies carried glistening oval balloons consisting of frothy matter. On drying, these very delicate structures collapsed and shrank to almost nothing. They quickly distintegrated when placed in alcohol.

The only balloon-making species of Empididae not belonging to the genus *Hilara* which has been recognized heretofore is *Empis aerobatica* Melander. This form was discovered by Aldrich and Turley (1889) during June near Moscow, Idaho. Their attention was first attracted to the glistening white balloons which were moving to and fro in the air some 8 or 10 feet above the ground. When some of these were captured it was revealed that each was carried by a male fly. The balloons were elliptical in shape, hollow,

and more or less open behind. Each was about twice the length of the fly which carried it and was composed of a layer of minute bubbles. The surface was sticky and in nearly every case there was a small dead fly pressed into the front end. The balloons were very delicate and collapsed and shriveled into flattened films within a few hours. One which was placed in alcohol disintegrated immediately.

1947 Observations

Returning to the observations of the writers on *Empimorpha geneatis*, it was February 22 that the first specimens for the 1947 season were seen going through their aerial balloon dance. The flies were in the same vicinity as in 1946, zigzagging to and fro among the Monterey pine trees, but this year they had moved the center of their activities to another tree. Since 1946, the one around which they had originally danced had been topped, thereby reducing its height by many feet. This change of location was a fortunate one because it facilitated observation in two important ways. For some reason, possibly a difference in prevailing air currents, the insects had reduced the altitude of the flight, frequently carrying on their dance not more than 6 feet above the ground in the new place. Furthermore, the new location provided a steady foundation for the stepladder when its use was required to study the flies at very close range.

The insects were observed to be active only in the early morning, appearing about 7:30 o'clock when the sun first struck the pine trees and continuing to fly until about 9 o'clock. On overcast days the period of activity was shortened, the dance beginning later and ending earlier. On rainy days, or if the fog was heavy, the flies did not even appear. The number of individuals seen dancing at one time varied considerably, ranging from a single individual at the beginning of the season or on overcast days to 20 or more on one sunny morning in the middle of March. The last flies were seen during the first week of April.

Specimens of *E. geneatis* are expert fliers and capable net dodgers, hence difficult to capture. A near miss sometimes causes a fly to drop his balloon which then either settles to the ground or is blown away by the wind. On other occasions a fly retains his grip on the balloon following a narrow escape from the net, but in doing so he loses both altitude and his balance and flies un-

certainly to a nearby shrub. Here he may rest for some minutes, allowing the observer to approach within a few inches and examine him closely. When swept roughly into the net the insects invariably drop their balloons, but when care is exercised and the stroke of the net is true and relatively gentle, they often hold tightly to their burdens and can be transferred with them to a breeding cage or other container. Imprisoned in vials they usually remain alive for 12 hours or so and in a screen-covered breeding cage provided with a fresh branch from the pine tree they sometimes survive as long as 24 hours. In both cases they frequently grip their balloons tenaciously until the very last. Invariably, however, they relax their hold when dying; this is also true when they are killed in cyanide bottles.

The balloons of *E. geneatis* vary somewhat in size, the larger ones averaging about 3 mm. in length or about half the length of the male fly. Sometimes, especially in the case of the smaller balloons which seem to lack the finishing touches, the shape is spherical, but typically it is somewhat flattened and elongated, suggestive of the likewise flattened type carried by the males of *H. sartor*. In most cases the width averages about 2 mm. and the thickness is approximately 1½ mm. The intensely white and glistening surface appears to be hard and dry but is actually quite viscid, so much so that when merely touched with a pine needle or insect pin it adheres thereto. Unfortunately, from the standpoint of ease in manipulation, subsequent release is difficult. The characteristic of brilliant and glistening whiteness seems to be possessed in greater or less degree by the balloons of all the species of Empididae for which they are described. Mik (1894), in writing of *H. sartor*, gives what is doubtless the best description of an observer's reaction to his first glimpse of dancing balloon flies: "One thinks one sees snowflakes in the sunshine which seem to change at intervals into shooting silver sparks."

The viscous quality of the balloon surface, although not mentioned in the literature for some species, is common to several. These include *H. maura* (the globular type of balloon without prey discovered by Hamm, 1928), *H. granditarsis* (Melander, 1940), and *E. aerobatica* (Aldrich and Turley, 1889). In many respects the balloons of the last form and of *E. geneatis* resemble each other most closely, in fact these seem to be the only two species known which have prey pressed into the sticky surface. The balloons of other prey-taking kinds seem to be composed invariably

of definite threads rather than of viscid globules, and in those cases where prey is present it forms the central nucleus of the balloon. In regard to *E. geneatis*, in every one of the approximately 130 balloons taken during the two seasons of collecting, the tiny prey was found attached to the anterior end with its abdomen and wings crushed into the surface. Never was there found to be more than a single prey to a balloon. For the 100 balloons examined during the 1947 season the prey represented three families as follows: Chalcididae 47, Tendipedidae 38, and Itonididae 15. The minute insects were always oriented so that the thorax and head projected free from the balloon, being directed forward and upward. It was always this projecting part of the prey's body that was grasped by the fly's middle feet when holding the balloon; never was an unmated male observed to grasp the balloon itself with his legs as described for *E. aerobatica* by Aldrich and Turley (1889). These authors illustrate the male of their species carrying his balloon by holding it with both the middle and the hind feet. In *E. geneatis* the only apparent contact between the feet and the balloon is where the middle tarsi are wrapped around the prey and in so doing touch the anterior surface. In this species the male sits, walks, and flies without relaxing his grip on the prey which he uses as a handle to hold the balloon.

In spite of its bulk the balloon inconveniences the male's flight in no apparent way. One fly easily took wing with six extra balloons adhering to the one he was carrying. The balloons of course are very light, 20 of them averaged only slightly in excess of 0.03 mg. each. Three male flies, by contrast, weighed 1.65 mg., 1.79 mg., and 1.88 mg. respectively, or more than 50 times the average weight of a balloon.

The question arises as to the length of time that a male carries the same balloon. It has been noted that caged specimens of *E. geneatis* sometimes live as long as 24 hours and that frequently they keep holding their balloons until they die. Certainly it is their instinct to retain the balloons indefinitely. In support of this conclusion it was discovered that uncaptured males do not discard their balloons when they retire from the morning dance. On several occasions males were found even in the late evening sitting among the pine needles and still holding their balloons. It seems, therefore, that a male which is unsuccessful in mating one day may keep the same balloon for another try the following day. However, the males are able to make new balloons when circumstances require

replacement of lost ones. This was determined when three of the flies which had dropped their ballons in the net were marked on the dorsum with a spot of yellow paint and released. One of the specimens captured the following morning had the yellow markings clearly visible. The balloon which he carried, although slightly smaller than the average, was otherwise normal, even to the pressed-in prey at the anterior end. Therefore, in order to avoid the depletion of the none-too-abundant *E. geneatis* population, it was decided that the considerable material needed for the chemical study should be collected by making use of this instinct to replace lost balloons. Subsequently, each male captured was immediately induced to drop his balloon and was then released to construct another one.

While no observations were made on the mating habits of *E. geneatis* during the 1946 season, considerable progress was made along this line in 1947. The only female taken during the first year was obtained quite by accident in company with a male which had been traced by following the path of his balloon as he floated away from the dancing group to settle high in the tree. The female, not heretofore observed, differs from the male by lacking the many, long, black, bristly hairs which occur in the latter sex on the face, cheeks, palpi, antennae, dorsum of the thorax, between the wings and halteres, and one the first abdominal segments. The occipital hairs of the female, although numerous, are much shorter than those of the male. Another sexual difference is the coloration of the occiput and the dorsum, both of these regions being noticeably less black in the female. The thoracic vittae are correspondingly more distinct in the female. Finally, the halteres and the proximal regions of the femora are definitely yellowish in the female instead of piceous black as in the male.

Because of the lower flight level of the insects during the 1947 season, it was possible for the observer to get very close to the swarm of males by standing on the stepladder. On several occasions he distinctly saw a female join the dancing group and zigzag in and out for a few turns among the balloon-carrying males. Then the blur of her black body fused with one of them, the mating flies with their balloon lost altitude for a moment, and the two floated off together to settle on the pine tree. Examination of the paired flies revealed that the male no longer held the balloon; doubtless he had transferred it to the female at their first contact in the air

and the preoccupation of the flies in this transfer was evidently responsible for the temporary loss of altitude of the mating pair.

As to the relative positions of the flies during copulation, the male is invariably astride the female, not the reverse such as Aldrich and Turley (1889) describe and figure for *E. aerobatica*. In the case of *E. geneatis* the male hangs to the pine needle by his front feet, his middle feet rest on the thorax of the female, and his hind legs straddle her abdomen, supporting her. The female holds the balloon with all of her feet touching its surface; never was she observed to grasp the prey as a handle for the balloon in the manner of the male, nor was she seen to make any attempt to keep the balloon orientated with the prey toward the front. Instead, she keeps turning the balloon from one position to another during copulation, apparently entirely unconcerned with the prey and certainly not trying to feed on it. This tiny insect is invariably unfit for food. Its abdomen is always ruptured and completely flattened against the balloon's surface. Indeed it is doubtful if this species ever captures prey for food; never were the insects found to be in possession of prey other than the tiny one attached to the balloon. It is possible that both the males and the females feed exclusively on plant juices. On several different days representatives of both sexes were found feeding on the flowers of manzanita bushes (*Arctostaphylos Cushingiana* Eastwood) which grow beneath the pine trees. They were found in company with two other species of Empididae which Dr. A. L. Melander kindly examined and found to be undescribed forms of *Acallomyia* and *Rhamphomyia (Holoclera)* respectively. Each of the flies observed was obtaining nectar by probing with its proboscis through a puncture which it had made in the base of the corolla. Here, as on all other occasions observed, the males of *E. geneatis* were carrying their balloons with them.

Discussion

Since the female does not so much as fondle the prey and the balloon alone seems to be the stimulus which prompts mating, the question arises as to why the male goes to the trouble of capturing the prey. Why does he not present the female with an empty balloon as is done in the cases of *H. sartor* and *H. granditarsis?* The answer doubtless lies in the evolutionary sequence of the balloon-making

habit which was first suggested by Hamm although published by Poulton (1913). Hamm recognized three more or less distinct stages to which Melander (1940) has added a fourth. To elaborate this supposed sequence still further and to find the exact place of *E. geneatis* in the series, the following stages may be recognized:

(1) Predaceous species in which the female is not averse to including the male among her victims.

(2) Avoiding any cannibalistic attention on the part of the female, the male presents her with prey as a wedding gift which she sucks during copulation.

(3) The prey, although still eaten by the female, has become the necessary stimulus for copulation.

(4) The prey is presented in a simple gift package consisting of silk-like threads or viscid globules which serve to quiet its struggles.

(5) The gift package is differentiated into a complex balloon which shares with the edible prey the function of stimulating mating.

(6) The prey has become useless as food but continues to share with the balloon the function of stimulating copulation.

(7) The prey, although still included, has lost its significance in courtship, the balloon remaining as the lone stimulus to copulation.

(8) The balloon without prey is presented to the female.

It is apparent that *E. geneatis* represents the seventh stage in the above series. Observations on the epigamic behavior of *E. aerobatica* have been too limited to determine whether this species belongs in the sixth or the seventh category. The earlier stages in the sequence are represented by numerous species and the last one is illustrated by both *H. granditarsis* and *H. sartor*. It will be remembered that this second hilaran was the first balloon fly to be discovered, a fact which made the interpretation of the significance of its balloon a perplexing problem to the early workers.

In regard to the production of the balloon substance, the fact that *E. geneatis*, like other important balloon makers, seems to be restricted to the immediate vicinity of coniferous trees, may have some not yet understood significance. As for the actual source of the secretion, the vacuolated globules which comprise the balloons suggest that it is produced by the digestive system as froth-like bubbles coming either from the mouth or the anus. An examina-

tion of the other evidence favors the latter region, so that the process of balloon construction may be assumed to be somewhat as follows:

The male first catches his victim, an act doubtless prompted by an instinct dating back to his predaceous ancestors in an earlier stage of the balloon-making sequence. Inasmuch as the female of this species ignores the prey, it is apparent that its only function is to stimulate the male to construct the balloon. Of course it is possible that his instinct for predaceousness on this occasion is strong enough to cause him to suck the body fluids from the prey, thereby collapsing its abdomen. It may be assumed that the male overtakes the tiny insect in flight from behind, at least the head of the latter is always directed forward and upward. While still flying and while holding the thorax of the prey with the middle tarsi, the male apparently bends the tip of his body under and forward between his hind legs to press the first viscous globules firmly against the prey, flattening its abdomen and gluing down its wings. It is reasonable to conclude that the whole balloon is made by adding more and more globules, one at a time. Considering the shape of the entire structure, projecting backwards as it does from the insect which forms its starting point, it is apparent that such a balloon must be constructed from behind.

Chemical Nature of the Balloons

Turning now from theory to fact, not much has been written heretofore concerning the chemical nature of the balloons of Empididae and all the available information has been summarized in an earlier portion of this paper. As for the balloons of *E. geneatis*, these were prepared for chemical study by first removing the tiny insect which adheres to the surface of each. Macroscopic examination at this time revealed no obvious threads in the balloon substance, but a microscopic study showed semicrystalline threads of a white shiny material.

A number of preliminary solubility tests were performed; one balloon was used for each experiment. In fat solvents such as benzene, chloroform, or ether the material dissolved to a small extent since a white residue was obtained upon removal of the solvent. The balloons were insoluble in solvents such as water, 20% sodium hydroxide, concentrated and dilute hydrochloric acids, and also in 70% and 95% ethyl alcohol. They were soluble in

warm 2% sodium hydroxide. They gave a negative Liebermann-Burchard reaction (for sterols) but gave a positive Molisch test (for carbohydrates) and a positive Biuret test (for proteins) (cf. Hawk and Bergheim, 1937). The tests were performed on a micro scale using known sterols, carbohydrates, and proteins as controls. Ignition of several balloons gave a white ash indicating the presence of inorganic matter.

Twenty balloons were weighed on a micro balance and gave a total weight of 0.66 mg., each balloon weighing approximately 0.033 mg. The balloons were then transferred to a small test tube and extracted twice with 1 ml. portions of ethyl ether. The combined ether extracts gave a white waxy residue on evaporation. The insoluble balloons after extraction and drying appeared to have the same microscopic characteristics as the original balloons except that the shiny lustre was gone. The balloons now weighed 0.57 mg. so that the fat soluble (lipid) fraction of the original balloons amounted to 0.09 mg. or 14% of the total weight. In spite of their extraction with ether the balloons still gave a white ash on ignition. The Molisch and Biuret tests were repeated on 0.2 mg. of balloon material with confirmation of the positive results. A negative van Wisselingh's test (Wigglesworth, 1942) indicated that chitin was not a constituent.

A chemical examination of the balloons, therefore, revealed the presence of protein, carbohydrate, lipid, and inorganic matter. The insolubility of the balloons in the various solvents indicated that the protein and carbohydrate fractions are of high molecular weight. Solubility in dilute but not in concentrated alkali pointed to a mucoprotein, as did the other tests (cf. Levene, 1926). An attempt was then made to stain the balloons with tolundine blue which resulted in a violet coloration specific for sulfated polysaccharides (Lison, 1936; Jorpes, 1936). This indicated that the balloons are composed of a mucoprotein (a protein conjugated with a carbohydrate such as mucoitin sulfuric acid) coated with a small amount of lipid matter. The inorganic ash supports the data.

Mucoproteins and other carbohydrate-protein complexes are widespread through nature and have been shown to be constituents of such diverse substances as the protoplasm of jellyfish, serum, saliva, and gastric mucin (Meyer, 1945; Stacey, 1946). These findings are not incompatible with the assumption that the balloons of *E. geneatis* originiate as secretions of the digestive tract.

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